Title: Nonlinear optical properties of semiconductor nanostructures

Abstract: Laser ablation of solid state wafer in liquids is a simple and reliable method for creation of nanocrystals of almost any kind of metals and semiconductors. We performed pulsed laser ablation of a silicon wafer in deionized water to prepare colloidal silicon nanocrystals. The samples were prepared by femtosecond laser ablation using Ti: sapphire laser (wavelength 800 nm, pulse duration 100 fs, pulse energy 0.06 mJ - 0.7 mJ, repetition rate 1 kHz) and characterised by time-integrated photoluminescence spectroscopy, extinction measurements, transmission electron microscopy (TEM), Raman spectroscopy, X-ray diffraction (XRD) and time-resolved measurements of photoluminescence.

The time-integrated photoluminescence spectrum demonstrated a blue emission. In addition, we observed that aging of nanocrystals in deionized water for several weeks improved the photoluminescence intensity. It is generally accepted that the unique properties of Si nanocrystals result from both quantum confinement size effect and surface states. Modification and oxide passivation of surface states and defects in oxide layer can effectively increase the photoluminescence intensity. Using extinction measurement it was found that absorption of nanocrystals is increased with increasing pulse energy. The TEM image showed the silicon nanoparticles with relatively broad size distribution. In Raman scattering spectra there were observed red shift and blue shift, respectively. Using XRD measurement two peaks of crystalline silicon were detected at 2θ = 28.39 ° and 47.30 °, corresponding to [111] and [220] directions.

In the case of time-resolved photoluminescence we did not observe photoluminescence signal. However we cooperated in measurement of photoluminescence dynamics of silicon nanocrystals prepared by another way. The decay of about 20 ps was observed in silicon nanocrystals in UV-ethanol.

We discussed observed results.